Space Weather Technical Forecast

Issued on Tuesday, 21 May 2024 at 01:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-class flares throughout. A reducing chance of G1-G2 (Minor/Moderate) Storm conditions early Day 1 (21 May).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with the largest event a C6.7 flare at 20/0554 UTC, which originated from AR3683 in the southwest quadrant. There are currently eight sunspot regions on the visible disc. The largest region remains AR3685 in the southeast. It comprises of a number of large, mature spots, with recent consolidation of some of the smaller spots. AR3679 in the southwest is the next largest region, which has shown some recent growth in its trailing portion. AR3683 in the southwest shows modest complexity, although this region is becoming difficult to analyse as it approaches the west limb. The other sunspot regions are generally smaller, simpler and generally stable.

A large filament lift-off from the southern hemisphere that began around 18/2200UTC has been modelled as missing below Earth' orbit. Another and more notable full halo CME was observed leaving the Sun early on 20 May, but further analysis revealed that it is far sided, with no impact at Earth. Otherwise, no Earth-directed CMEs were observed in the past 24 hours in coronagraph imagery.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 have been on a steady decline, generally towards background levels, with speeds ranging between 330-430km/s. Density has been below average throughout the period. The Interplanetary Magnetic Field (IMF), Bt, was weak to moderate, with a peak of 9nT. The north-south component Bz was stable and fluctuating slowly from +/-6nT during the period. Phi angle was predominately positive (away from the Sun). Geomagnetic activity was at mostly Quiet to Unsettled (Kp0-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) remained below the S1/Minor Radiation Storm levels and are now at normal background levels. High energy electron flux (greater than 2MeV) observed by GOES-16 was at background to moderate levels, with a peak of 513 pfu at 20/1410UTC. The associated 24-hour fluence has remained below the Active threshold. Observed fluence at 21/0000 UTC of 1.34e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a chance of isolated M-class flares and a very slight chance of isolated X-class flares. AR3685 is most likely to be the source of significant flare activity.

Solar Wind / Geomagnetic Activity: There is the chance of a glancing blow from a CME at Earth early day 1 (21 May), resulting from the M7.2 flare of AR3685 that occurred late on 17 May. In the meantime, solar winds are forecast to remain at or near background speeds, with no significant coronal hole enhancements expected.

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A possible glancing blow from a CME (which left the Sun on 17 May) could arrive at Earth early Day 1 (21 May) with a chance of Active to G1-G2/Minor-Moderate (Kp5-6) intervals. Activity should then subside towards Quiet to Unsettled levels by Day 2 (22 May).

Energetic Particles / Solar Radiation: Proton flux is below the S1/Minor Storm threshold and at background levels. There is a persistent slight chance of further enhancements should any large flares occur.

High energy electron flux is at background to moderate levels. There is the potential for the electron flux to rise and potentially reach high levels at the end of the period but the chance is considered low since any enhancement is likely to be curtailed by any CME influences over coming days. The associated 24 hour fluence is expected to remain well below the Active threshold, even if it is likely to rise at the end of the period. The risk of exceeding the Active threshold is low but considered possible on Days 3 and 4 (23-24 May) though dependent on the extent of any CME enhancement.

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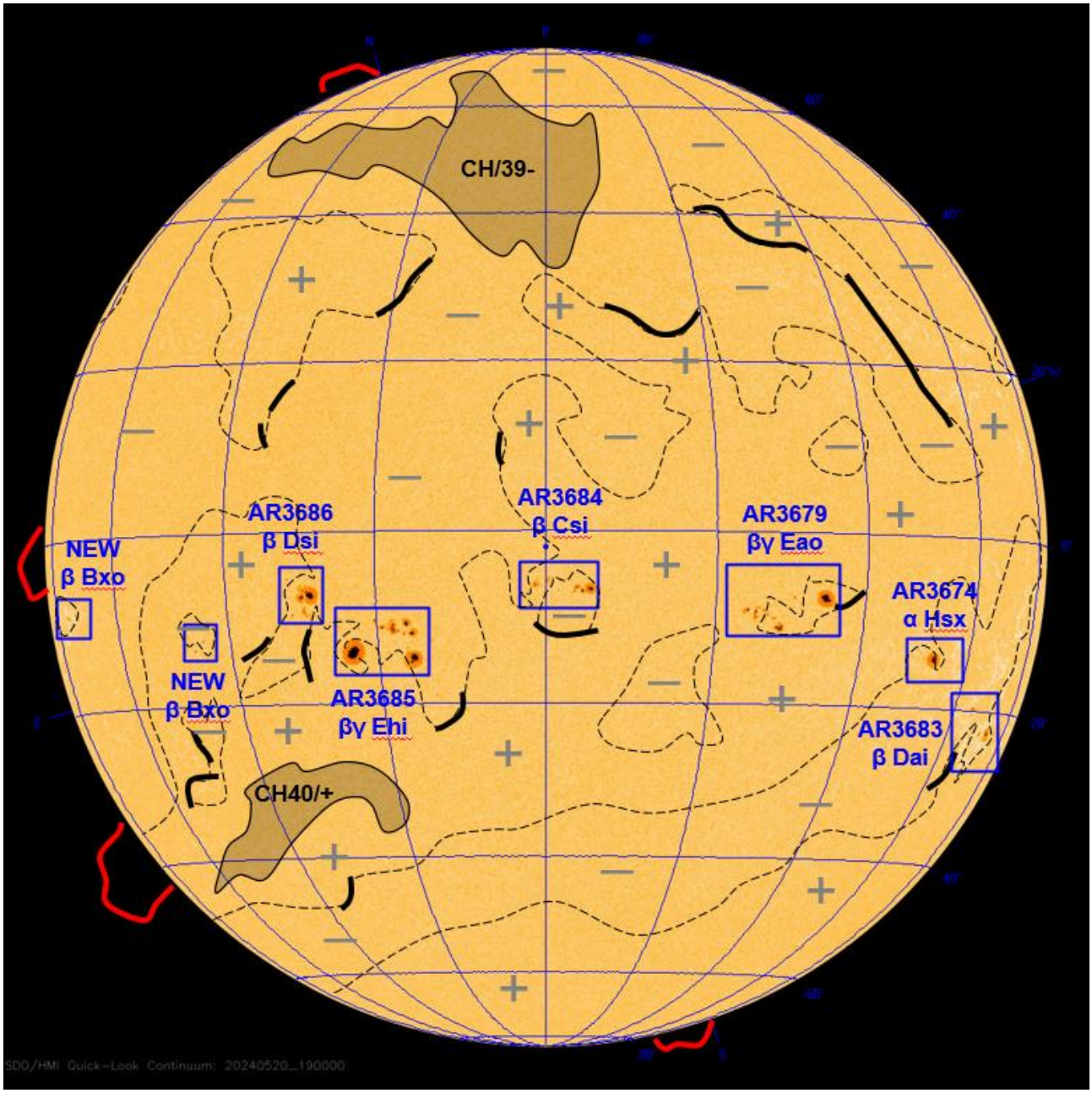
Figure 1. Solar Analysis Valid 20/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A potentially Earth-directed CME currently features in this forecast period. Late on 17 May a complex 'double-structured' moderately-fast CME was seen in coronagraph imagery associated with the M7.2 flare of AR3685 in the southeast disc. Type II and IV Radio Emissions as well as a distinct EUV wave signature were observed. Modelling of this feature suggests the potential for a glancing impact early day 1 (21 May).

Another and more notable full halo CME was observed leaving the sun early on 20 May, but further analysis has revealed that it is far sided, with no impact at Earth. No further Earth-directed CMEs were observed.

A chance of Active to G1-G2/Minor-Moderate (Kp5-6) intervals initially during the early hours of Day 1 (21 May). Activity should then subside towards Quiet to Unsettled levels by Day 2 (22 May).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	1	1	1
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
18/0039	Partial	AR3665	SE	950 km/s	20/2000 UTC	Chance of glancing impacts

Figure 2: MOSWOC Enlil and Ensemble shows possible glancing CME arriving at Earth early on day 1 (21 May) – although confidence is low.

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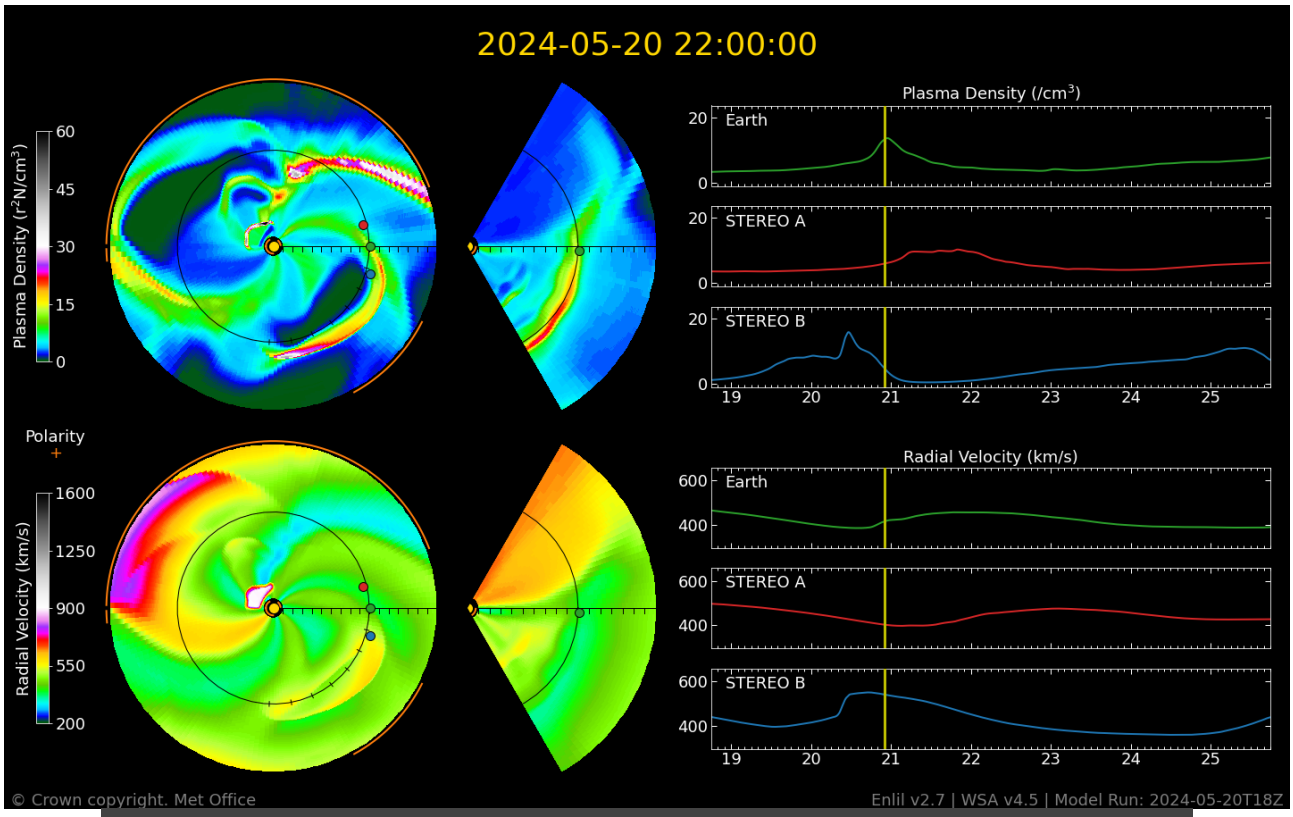

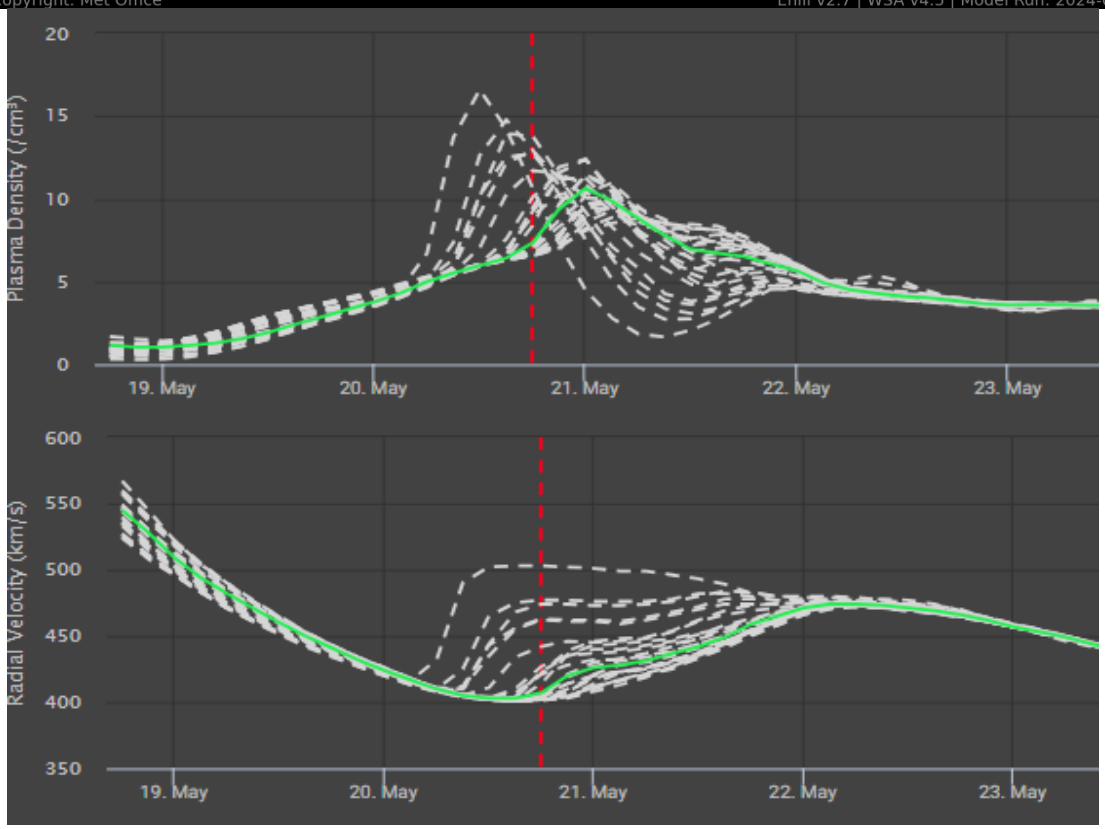

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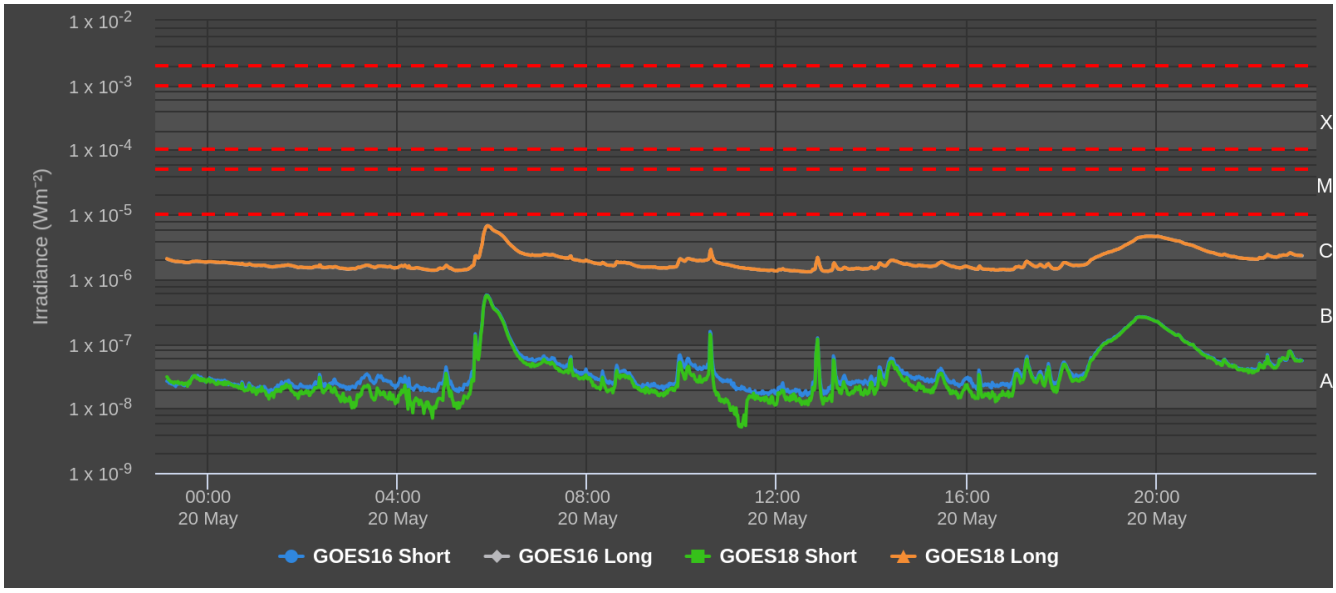
Radio Blackouts - X-Ray Flares:
There are currently eight sunspot regions on the visible disc. The largest region remains AR3685 in the southeast. It comprises of a number of large, mature spots, with recent consolidation of some of the smaller spots. AR3679 in the southwest is the next largest region, which has shown some recent growth in its trailing spots. AR3683 in the southwest shows modest complexity, with some minor growth in recent hours, with a new trailer spot emerging. The other sunspot regions are generally smaller, simpler and generally stable.

No significant returning regions are expected through the period or strongly signalled in far-side sounding data, with all the current notable flare producing regions remaining on the visible disc though the next four days. As such, the current flare risks have been maintained through the period pending further developments.

Low to Moderate activity is expected with a chance of isolated M-class flares and a very slight chance of isolated X-class flares. AR3685 is most likely to be the source of significant flare activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES18 X-Ray flares trace.



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Solar Radiation Storms - (High Energy Protons):

Proton flux is below the S1/Minor Storm threshold, and has returned to normal background levels. There is a persistent slight chance of further enhancements should any large flares occur, especially given the number of sunspot regions on the Earth-facing disc. AR3685, the largest and most actively flaring region on the disc will, however, remain in a generally unfavourable position (in the eastern hemisphere) for significant proton enhancement throughout.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16 is at background to moderate levels. There is the potential for the electron flux to rise and potentially reach high levels at the end of the period but the chance is considered low since any enhancement is likely to be curtailed by potential glancing CME influence over the coming day.

The associated 24 hour fluence is expected to remain well below the Active threshold, even if it is likely to rise at the end of the period. The risk of exceeding the Active threshold is low but considered possible on Day 4 (23rd) though dependent on the extent of any CME enhancement. In the absence of CME enhancements MOSWOC REFM looks to be providing reasonable guidance, although perhaps slightly over representing the risk of reaching the Active threshold later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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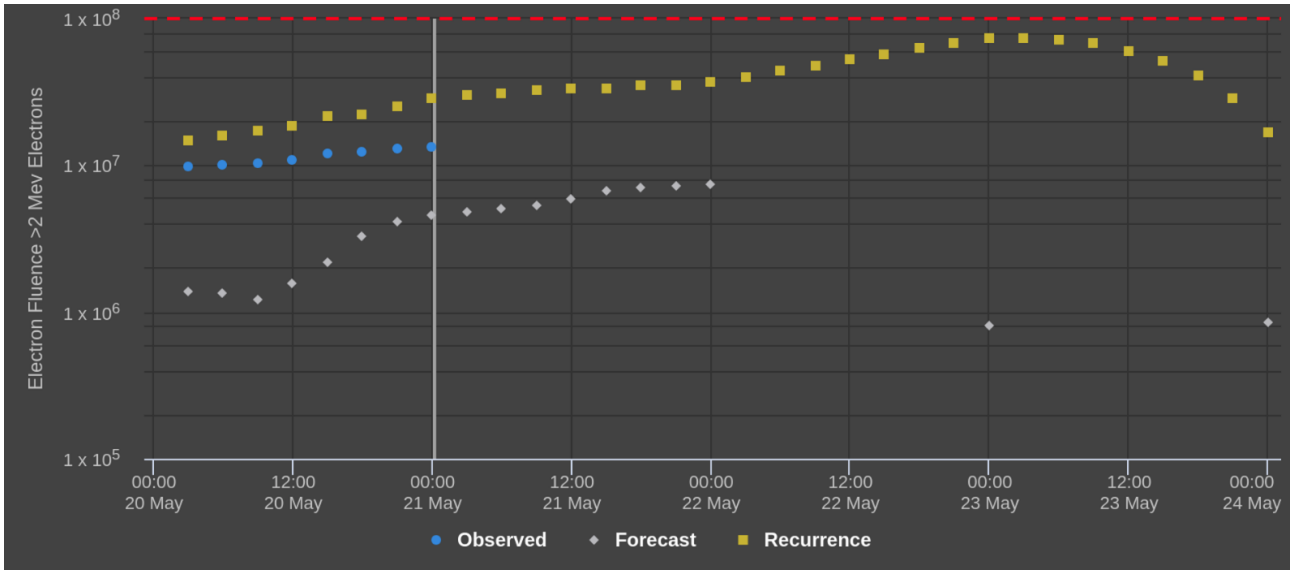
Figure 4: MOSWOC REFM electron fluence.



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